SB761
U7R6
#77-18

Forest Insect and Disease Management

5230
BIOLOGICAL
EVALUATION R2-77-18

SOIL FUMIGATION WITH
METHYL BROMIDE-CHLOROPICRIN

Mt. Sopris Tree Nursery
Carbondale, Colorado

SEPTEMBER 1977

LIBRARY
FEB 15 1978
ROCKY MOUNTAIN STATION

Rocky Mountain Region

U.S. Department of Agriculture Forest Service

5230
BIOLOGICAL
EVALUATION R2-77-18

SOIL FUMIGATION WITH METHYL BROMIDE-CHLOROPICRIN

Mt. Sopris Tree Nursery
Carbondale, Colorado

SEPTEMBER 1977

PREPARED BY: Linnea S Gillman
Linnea S. Gillman
Biologist

APPROVED BY:

A L Downing
G. L. DOWNING
Staff Director
Forest Insect and Disease Management

for Craig A. Giffen
F. A. DOBRELL
Deputy Regional Forester
State and Private Forestry

Forest Insect and Disease Management
State and Private Forestry
Rocky Mountain Region
USDA Forest Service
11177 W. 8th Avenue
Lakewood, Colorado 80225

INTRODUCTION

Seedling losses in nonfumigated beds at Mt. Sopris Tree Nursery have been higher than acceptable in the past. In 1976, a seedling loss analysis (Landis 1976) demonstrated that damping-off fungi were causing an average of 25% loss of emerged Engelmann spruce, lodgepole pine, and ponderosa pine, with up to 80% loss in some beds. Weeds, especially purslane, (*Portulaca oleracea* L.), have become an increasing problem in recent years. The herbicide Dymid®, which has been used since 1972, has failed to give adequate control. Dowfume® MC-33 (methyl bromide, 67%; chloropicrin 33%) was used to fumigate six nursery blocks (25 acres) in September 1976 (Landis et. al. 1976). The counts of damping-off fungi dropped significantly, weed seeds were killed, and seedling survival in the fumigated beds in 1977 was better than in previous years. Looking at weed control alone, the benefit/cost ratio in 1976 was 2 : 1. Hand weeding cost $1,654 per acre and fumigation cost $800 per acre.

Due to the favorable results of the 1976 fumigation, five blocks (25 acres) at Mt. Sopris Tree Nursery, to be sown in 1978, were fumigated with Dowfume® MC-33 at 400 lb/acre in September 1977 (see map). Soil samples were taken before and after fumigation to determine the effect on populations of Pythium, Fusarium, and weed seeds.

METHODS

Soil samples for analysis of pathogenic fungi and weeds were taken with a 2 cm diam. soil probe. In each of the 5 blocks (1, 3, 6, 7, and 9 - see map) a core of the top 15 cm of soil was taken every 15 feet on a line diagonally across the block. The cores for a block were mixed to give 1 sample per block.

In Block 1 additional samples for analysis of pathogenic fungi were taken in five plots (130 x 4 feet long) where the Abbott-Pisolithus Nursery Testing Program will be installed. The objective of this nationwide pilot test is to evaluate the effectiveness of a commercially-produced mycorrhizal inoculum for increasing survival and growth of conifers in nurseries and outplanting sites. In each plot, 3 samples were taken at 3 soil depths: A = 0 - 5 cm; B = 12.5 - 17.5 cm; and C = 25 - 30 cm. Each of the three samples (A, B, and C) in a plot were the composite of cores taken at

15 foot intervals along the plots (130 feet long). At each sample point, 3 cores were taken 1 foot apart at each of the 3 depths. All soil samples were stored in paper sacks under refrigeration until processed at the Forest Insect and Disease Management lab in Lakewood. Soil samples were taken in September 1977 1 week prior to fumigation and again 2 days after the plastic tarp had been removed following fumigation. Blocks 1, 3, 6, 7, and 9 were fumigated with Dowfume ® MC-33 at the rate of 400 lbs/acre by Hendrix and Dail, Inc., soil fumigation specialists from Greenville, North Carolina. The fumigant was injected 6 inches into the soil through chisels spaced 18 inches apart and the soil was immediately covered with plastic tarp. The tarp was left in place 2 days or more (2 days in Block 1).

The pre- and post-fumigation soil samples were taken to the lab and processed as follows:

> Each sample (5 from Blocks 1, 3, 5, 7, and 9; 15 from Plots 1 - 5 in Block 1) was cultured on selective media for species of Pythium (Hendrix and Kuhlman 1965) and Fusarium (Nash and Snyder 1962). Estimates of soil populations were calculated as propagules per gram (ppg) of soil (field moist soil for Pythium, air-dried soil for Fusarium). To estimate the number of viable weed seeds, 590 cm^3 of soil from the 15 cm deep samples in Blocks 1, 3, 6, 7, and 9 was spread 1.5 cm deep in petri dishes and kept moist under lights for 2 weeks. At that time all seedlings were counted. A soil analysis was performed by Agricultural Consultants Laboratory, Brighton, Colorado, on a composite sample of the top 15 cm of soil from the 5 plots in Block 1.

RESULTS

The counts of pathogenic fungi and weeds from the top 15 cm of soil in Blocks 1, 3, 6, 7, and 9 are presented in Table 1. Pythium (ppg) was reduced from a prefumigation estimate of 167 to a post-fumigation estimate of 0. Fusarium (ppg) was reduced from a prefumigation estimate of 6,200 to a post-fumigation estimate of 0. Viable weed seeds were reduced to 0 from an average prefumigation estimate of 11 per 590 cm^3 of soil. The results of Fusarium counts are given both as ppg and as colonies per plate so that the results may be compared to the results in 1976 (Landis et. al. 1976).

The counts of pathogenic fungi from the five plots in Block 1 are listed in Table 2. The ppg of Pythium were reduced to 0 by fumigation in samples A and B in all except one sample where the post-fumigation count was 1 ppg. The average pre-fumigation counts for samples A, B, and C were 163, 170 and 175 ppg respectively, indicating little variation between the 3 depths of sampling. One sample at depth C showed a residual population of 9 ppg Pythium. The ppg of Fusarium were reduced to 0 in all A and B samples and in 3 of 5 C samples. Two of the C samples contained a residual population.

DISCUSSION

The average levels of Pythium in September 1977 before fumigation were 3 times higher than in September 1976, and Fusarium counts were slightly higher. Weed counts in 1976 and 1977 were comparable. Although there is no data available yet to correlate counts of damping-off fungi to seedling survival, the population levels we obtained were much higher than the levels reported to be damaging in an Oregon nursery (Johnson and Zak 1977). This fact, in addition to the history of damping-off in nonfumigated beds at Mt. Sopris, suggested the need for fumigation. The benefit of fumigation for weed control was clearly demonstrated by the 1976 fumigation.

There is the possibility that some weed seeds and pathogenic fungi may reinvade the fumigated soil by planting time in 1978. Strong winds that occur during the winter may blow in weed seeds from adjacent uncultivated and nontreated areas around the nursery. Sterilized seedbeds can be reinfested with pathogenic fungi by irrigation, water splashing, rain, wind-blown dust, and soil carried by man (Vaartaja 1967). The small residual population of fungi left at the 25-30 cm depth may be sufficient to repopulate the soil (Thies 1975), especially if it is disturbed during seedbed preparation in the spring. In order to predict problems that may arise from possible reinfestation by weeds and fungi, soil samples will be taken in the spring of 1978 before sowing and at regular intervals thereafter. If a problem arises, control methods (fungicides, herbicides) will be applied.

REFERENCES

HENDRIX, F. F., Jr. and E. G. KUHLMAN. 1965. Factors affecting direct recovery of *Phytophthora cinnamomi* from soil. Phytopathology 55:1183-1187.

JOHNSON, D. W. and B. ZAK. 1977. Effects of soil treatments on fungal populations and ponderosa pine seedling survival in an Oregon nursery. Plant Dis. Reptr. 61:43-47.

LANDIS, T. D. 1976. An analysis of seed and seedling loss at Mt. Sopris Tree Nursery. USDA, For. Serv. R-2, Forest Insect and Disease Managememement. Bio. Eval. R2-76-18. 7 p.

LANDIS, T. D., L. S. GILLMAN, and D. M. HILDEBRAND. 1976. Effectiveness of soil fumigation with methyl bromide-chloropicrin at Mt. Sopris Tree Nursery. USDA, For. Serv. R-2, Forest Insect and Disease Management. Bio. Eval. R2-76-15. 6 p.

NASH, S. M. and W. C. SNYDER. 1962. Quantitative estimations by plate counts of propagules of the bean root rot Fusarium in field soils. Phytopathology 52:567-572.

THIES, W. G. 1975. Evaluation of fumigation with methyl bromide-chloropicrin to reduce the number of propagules of *Pythium* spp. and *Fusarium* spp. in seedbeds at the Bend Nursery. Office Report, USDA, For. Serv. Pacific Northwest Region. Portland, Oregon. 6 p.

VAARTAJA, O. 1967. Reinfestation of sterilized nursery seedbeds by fungi. Can. J. Microbiology 13:771-776.

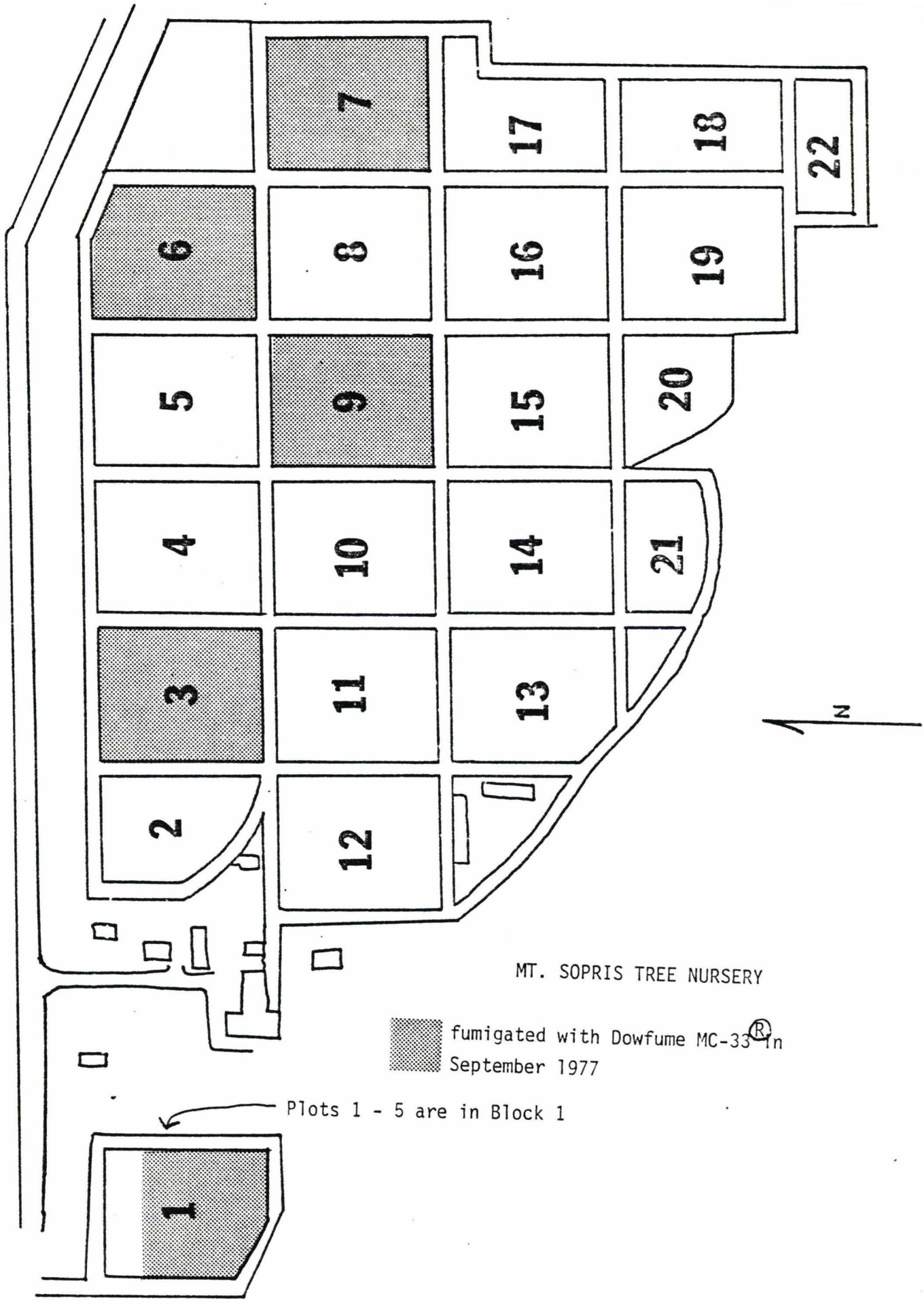
7
17
18
22
6
8
16
19
5
9
15
20
4
10
14
21
3
11
13
2
12
1
N
MT. SOPRIS TREE NURSERY
fumigated with Dowfume MC-33® in September 1977
Plots 1 - 5 are in Block 1

TABLE 1 Fumigation effectiveness for damping-off fungi and weed seeds at Mt. Sopris Tree Nursery, September 1977

Type of Pest	Sample	Units	Nursery Block 1	3	6	7	9	$\bar{X}$
Damping-off fungi								
Pythium spp.	Pre-fumigation	propagules per gram of soil (ppg)	171	173	160	173	157	167
	Post-fumigation		0	0	0	0	0	0
Fusarium spp.	Pre-fumigation	ppg	4,800	10,900	3,100	8,700	3,600	6,200
		(colonies per plate)	(12)	(27)	(8)	(2)	(9)	(15)
	Post-fumigation	ppg	0	0	0	0	0	0
		(colonies per plate)	(0)	(0)	(0)	(0)	(0)	(0)
Weed Seeds	Pre-fumigation	germinants per 590 cm^3 soil	11	14	21	2	5	11
	Post-fumigation		0	0	0	0	0	0

TABLE 2 Fumigation effectiveness for damping-off fungi at 3 soil depths in Block 1 of Mt. Sopris Tree Nursery, September 1977

Pythium (ppg) pre-fumigation

Soil depth	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	$\bar{X}$
A (0 - 5 cm)	138	167	222	201	87	163
B (12.5 - 17.5 cm)	189	170	168	209	114	170
C (25 - 30 cm)	198	162	215	173	126	175
$\bar{X}$	175	166	202	194	109	

Pythium (ppg) post-fumigation

Soil depth	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	$\bar{X}$
A	0	0	0	0	1	.2
B	0	0	0	0	0	0
C	0	1	0	0	9	2
$\bar{X}$	0	.3	0	0	2	

Fusarium (ppg) pre-fumigation

A (0 - 5 cm)	4,500	8,500	9,200	8,300	3,100	6,700
B (12.5 - 17.5 cm)	6,000	8,500	11,200	10,100	4,300	8,000
C (25 - 30 cm)	4,000	15,100	3,300	2,000	7,900	6,500
$\bar{X}$	4,800	10,700	7,900	6,800	5,100	

Fusarium (ppg) post-fumigation

A	0	0	0	0	0	0
B	0	0	0	0	0	0
C	0	1,900	0	0	5,300	3,600
$\bar{X}$	0	600	0	0	1,800	

PESTICIDE USE STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key -- out of the reach of children and animals -- and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicides from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary land-fill dump, or crush and bury them in a level, isolated place.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U. S. Department of Agriculture, consult your county agricultural agent or State Extension specialist to be sure the intended use is still registered.